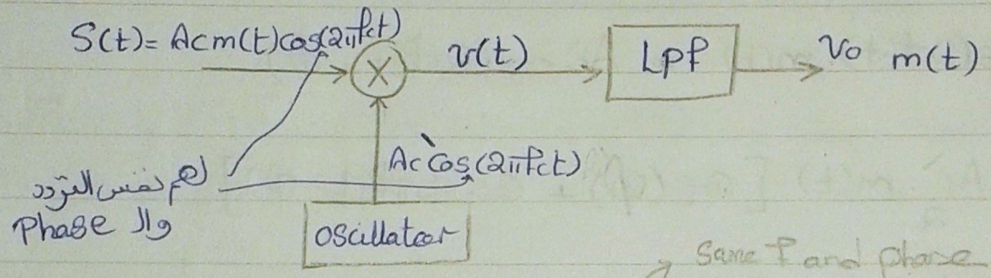
* Demodulation of D.S.B.S.C :

.أي عملية إستخلاص $m(t)$ من $S(t)$

[1] Coherent demodulation :

Coherent means that the local oscillator signal is sync. with Sc

في هذه الحالة سوف نستخدم oscillator له خرج أي عبارة عن $A_c \cos 2\pi f_c t$ Cos
له نفس التردد و الـ Phase مثل $c(t)$



*. assume that oscillator's o/p is coherent & sync to the modulated carrier

let $S(t) = A_c\, m(t) \cos(2\pi f_c t)$

$$v(t) = S(t) * A_c \cos(2\pi f_c t)$$

$$= (A_c\, m(t) \cos(2\pi f_c t))(A_c' \cos(2\pi f_c t))$$

$$= A_c A_c' \cdot m(t) \cdot \cos^2(2\pi f_c t)$$

$$= \frac{A_c \cdot A_c' \cdot m(t)}{2} (1 + \cos(4\pi f_c t))$$

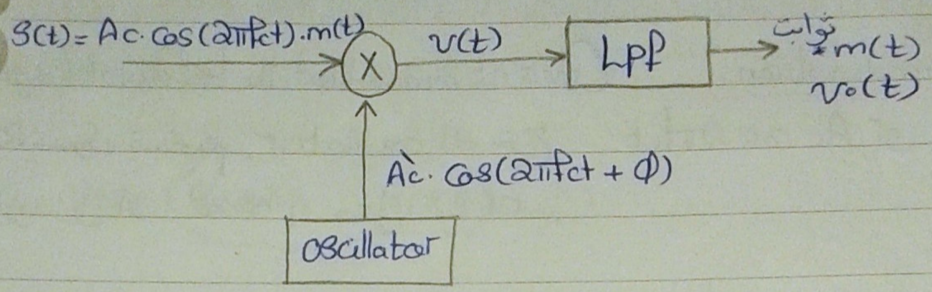
ضعف التردد

$$v(t) = \underbrace{\frac{A_c A_c' m(t)}{2}}_{\text{مطلوب}} + \underbrace{\frac{A_c A_c' m(t)}{2} \cdot \cos(4\pi f_c t)}_{\text{غير مطلوب}}$$

After LPF

$$v_o = \frac{A_c A_c'}{2} \cdot m(t)$$

* If the local oscillator's output is not exactly coherent with $c(t)$ & has a phase shift ϕ from the carrier phase.



$$v(t) = A_c \cdot \cos(2\pi f_c t) \cdot m(t) * A_c' \cos(2\pi f_c t + \phi)$$

$$= \frac{A_c \cdot A_c' \cdot m(t)}{2} \left[\cos(\phi) + \cos(4\pi f_c t + \phi)\right]$$

$\cos(m) \cdot \cos(n) = \frac{1}{2}\left[\cos(m-n) + \cos(m+n)\right]$

ثابت

$$= \underbrace{\frac{A_c \cdot A_c'}{2} m(t) \cdot \cos(\phi)}_{\text{الجزء المطلوب الذى يحتوى } m(t) \text{ وهعديه ب } LPF} + \underbrace{\frac{A_c A_c'}{2} m(t) \cos(4\pi f_c t + \phi)}_{\text{الجزء المرفوض الذى سيمنعه الـ } LPF}$$

$$v_o(t) = \frac{A_c \cdot A_c'}{2} m(t) \cos(\phi) \rightarrow \text{if } \phi = 90^\circ \rightarrow V_o(t) = 0$$

مشكلة حلها الـ Square Loop

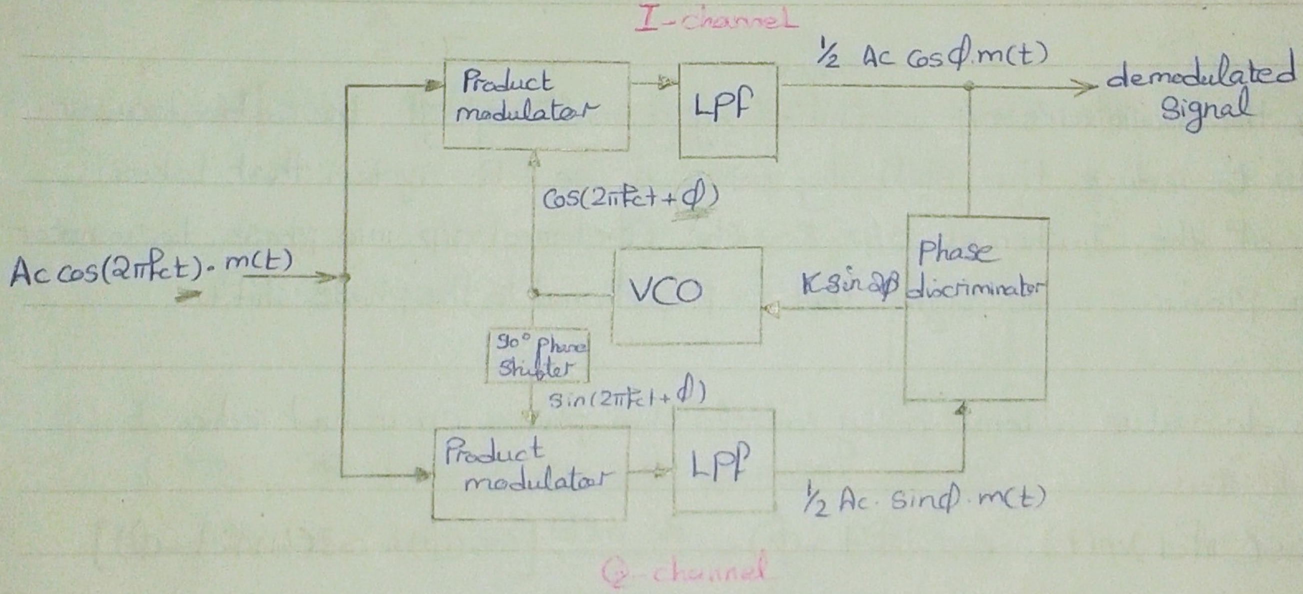
Date

2 Costas Receiver

- Practical Synchronous receiving system "Sync. means that it tends to make the oscillator's o/p phase equal to S(t) phase".

- The System contains
  - two Coherent detectors
  - phase discriminator "multiplier + LPF"

- A Voltage-Controlled Oscillator (VCO) is a device whose output frequency depends on its input Voltage.



- First, if the oscillator's o/p is of the same phase as the incoming DSBTC wave then, the I-channel will have the desired m(t) signal and the Q-channel will have zero signal.

I-channel $A_c . \cos(2\pi f_c t) . m(t) \cdot \cos(2\pi f_c t) = \frac{A_c}{2} m(t) \left(1 + \cos(4\pi f_c t)\right)$

$$= \underbrace{\frac{A_c}{2} m(t)}_{\text{Pass through LPF}} + \frac{A_c}{2} m(t) \cos(4\pi f_c t)$$

Q-channel

$$A_c \cdot \cos(2\pi f_c t)\, m(t)\, \sin(2\pi f_c t) = \frac{A_c \cdot m(t)}{2}\left[\sin(0) + \sin(4\pi f_c t)\right]$$

$$= \underbrace{\frac{A_c \cdot m(t)}{2} \cdot \sin(4\pi f_c t)}_{\text{لن تمر من ال LPF}}$$

$\therefore$ o/p of LPF will be Zero.

- The oscillator cos signal is phase shifted by 90° so, it is shifted into a sine wave, a signal and its 90° shifted signal are called in phase Quadrature

- If, the oscillator's o/p is phase shifted by a small angle ϕ, the costas receiver tends to reduce this shift by using a -ve F.B. system that takes part of the I-channel o/p & the Q-channel o/p into phase discriminator which produces a dc signal that is proportional to the phase shift.

- This dc value automatically controls this phase error and reduce it.

I-channel

$\cos * \cos = \frac{1}{2}\left(\cos(\text{الفرق}) + \cos(\text{المجموع})\right)$

$$A_c \cos(2\pi f_c t)\, m(t) \cdot \cos(2\pi f_c t + \phi) = \underbrace{\frac{A_c \cdot m(t)}{2}\left[\cos(\phi)\right.}_{\text{through LPF}} \left. + \cos(4\pi f_c t + \phi)\right]$$

Q-channel

$\sin A * \cos B = \frac{1}{2}\left[\sin(\overset{A-B}{\text{الفرق}}) + \sin(\overset{A+B}{\text{المجموع}})\right]$

$$A_c \cdot \cos(2\pi f_c t)\, m(t) \cdot \sin(2\pi f_c t + \phi) = \underbrace{\frac{A_c \cdot m(t)}{2}\left[\sin(\phi)\right.}_{\text{through LPF}} \left. + \sin(4\pi f_c t + \phi)\right]$$

At phase discriminator

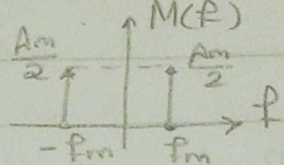
$$\frac{A_c}{2} m(t) \cos\phi * \frac{A_c}{2} m(t) \sin\phi = \frac{A_c^2 m^2(t)}{4} \cdot \frac{1}{2}\left[\sin(0) + \sin 2\phi\right]$$

$$= \frac{Ac^2 m^2(t)}{8} \sin 2\phi .$$

↳ this term will through LPF and dc Part will only Pass. and the o/p of it will be $K \cdot \sin(2\phi)$.

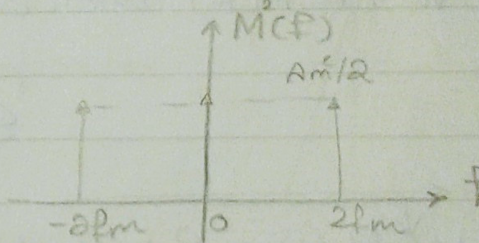
Note:-

assume $m(t) = Am \cos(2\pi f_m t)$



$$m^2(t) = \frac{Am^2}{2}(1 + \cos 4\pi f_m t)$$

$$\therefore M^2(f) = \frac{Am^2}{2}\delta(f) + \frac{Am^2}{2}\left[\delta(f-2f_m) + \delta(f+2f_m)\right]$$

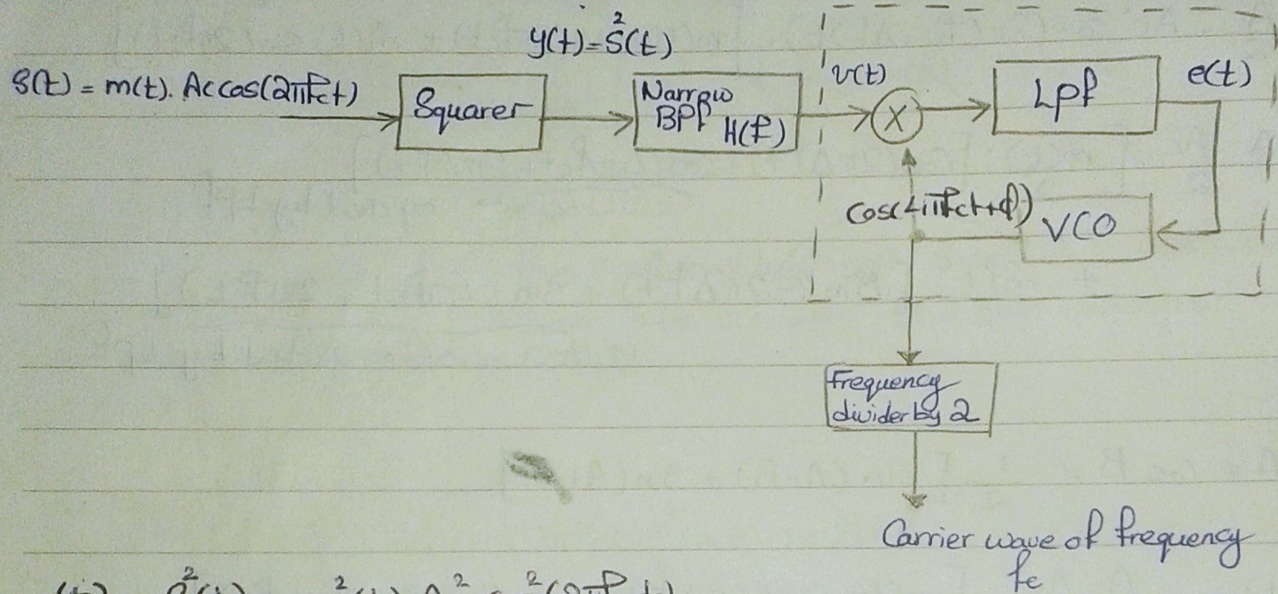


$\therefore$ LPF will Pass the delta Component at $f=0$ which will be $K \sin(2\phi)$.

Demod. of DSBSC تابع

Squaring loop

الهدف منها عمل Carrier لها نفس ال f وال Phase مثل ال Carrier
في الإشارة المستقبلة لعمل Coherent detection لها بعد ذلك.



$$y(t) = s^2(t) = m^2(t)\, A_c^2 \cos^2(2\pi f_c t)$$

$$= \frac{A_c^2}{2} . m^2(t) . \left[1 + \underbrace{\cos(4\pi f_c t)}_{\text{will pass}}\right]$$

- after the BPF which is centered at $2f_c$.

$$v(t) = \frac{A_c^2}{2} . E\Delta f \cos(4\pi f_c t)$$

- $v(t) . \cos(4\pi f_c t + \phi)$

$$= \frac{A_c^2}{2} E\Delta f . \frac{1}{2}\left[\underbrace{\cos(\phi)}_{\text{through LPF}} + \cos(8\pi f_c t + \phi)\right]$$

- $e(t) = K . \cos\phi$

  which will adjust the VCO until its o/p is
  $\cos(4\pi f_c t) \rightarrow$ has $f = 2f_c$

- The desired freq. is then $\underline{\underline{f_c}}$ after division by two.